Palladium-catalyzed arylation of ketones and acetonitrile with *ortho*-alkylation of aryl rings: de novo synthesis of tetralines and benzocycloheptenes

Chuanhu Lei, Jiajia Cao and Jianrong (Steve) Zhou*

Division of Chemistry and Biological Chemistry, School of Physical and Mathematical Sciences, Nanyang Technological University, 21 Nanyang Link, Singapore 637371

Supporting information: procedures and characterization of compounds

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I. General information

All NMR spectra were acquired on Bruker 500 MHz, 400 MHz or 300 MHz NMR spectrometers. ^{1}H NMR chemical shifts were recorded relative to TMS (δ 0.00) or residual protiated solvents ($CDCl_3$: δ 7.26). Multiplicities were given as: s (singlet), d (doublet), t (triplet), q (quartet) and m (multiplet). The number of protons (n) for a given resonance was indicated by nH. Coupling constants were reported as a *J* value in Hz. ^{13}C NMR spectra were obtained at 125 MHz on 500 MHz, 100 MHz on 400 MHz, or 75 MHz on 300 MHz NMR instrument and chemical shifts were recorded relative to solvent resonance ($CDCl_3$: δ 77.16). ^{19}F NMR spectra were recorded at 376 MHz on 400 MHz NMR spectrometers without any external standard. Proof of purity of new compounds was demonstrated with copies of ^{1}H, ^{13}C and ^{19}F NMR spectra.

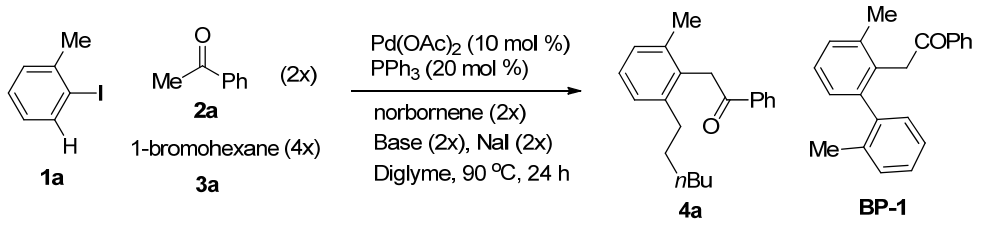
Glassware was dried at 120 ^{o}C for at least 3 h before use. Anhydrous 1,4-dioxane (Sigma-Aldrich), THF (Sigma-Aldrich) and diglyme (Sigma-Aldrich) were used without further purification and were stored in the argon-filled glove box. Other solvents used in the solvent optimization were dried and purified according to the procedure from "Purification of Laboratory chemicals book". All of dry solvents were stored in the glove box. Dry NaOH powder must be used to obtain reproducible results. NaOH pellet was grounded with pester and mortar in the glove box and then the powder was dried in a vacuum oven overnight at 150 ^{o}C.

Unless noted otherwise, commercially available chemicals were used as received without purification. The GC internal standard, *n*-$C_{12}H_{26}$ was degassed with argon and dried over activated 4 Å molecular sieve beads before use. Flash chromatography was performed using Merck 40-63D 60 Å silica gel. Gas chromatography (GC) analysis was performed on a Shimadzu GC-2010 instrument with Agilent J & W GC column DB-5MS-UI. GC/MS analysis was conducted on a Thermo Scientific DSQ II single quadrupole GC/MS instrument with Agilent J & W GC column DB-5MS-UI. High resolution mass spectral (HRMS) analysis was recorded on Waters Q-TOF Premier mass spectrometer.

II. Condition optimization for coupling of a model ketone

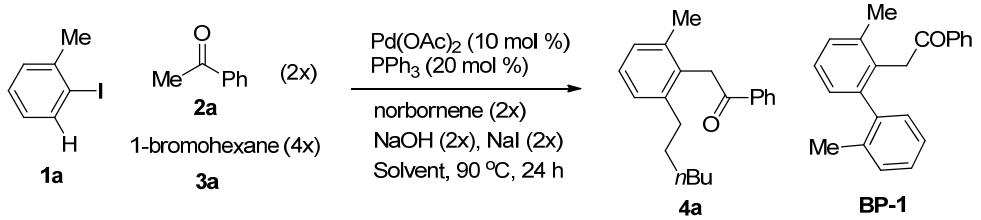
A typical procedure for condition optimization for couplings of ketones: In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with $Pd(OAc)_2$ (10 mol%, 2.2 mg, 0.01 mmol), P(*p*-tolyl)$_3$ (20 mol%, 6 mg, 0.02 mmol) and dry 1,4-dioxane (1 mL). After stirring for about 10 min at room temperature, *o*-iodotoluene (22 mg, 0.1 mmol), 1-bromohexane (66 mg, 0.4 mmol), norbornene (19 mg, 0.2 mmol), NaOH powder (8 mg, 0.2 mmol), NaI (30 mg, 0.2 mmol), acetophenone (24 mg, 0.2 mmol) and GC standard *n*-dodecane (10 μL) were added sequentially. The tube was capped tightly and the reaction mixture was heated at 90 °C for 24 h. At the end of reaction, the mixture was cooled to rt. Aliquots of the reaction mixture were passed through a short plug of silica gel with ethyl acetate washings. The filtrate was analyzed by GC for the determination of conversion of *o*-iodotoluene and calibrated GC yields of the product and the byproduct.

Table S1. The effect of bases in a model reaction of acetophenone using PPh_3 as ligand



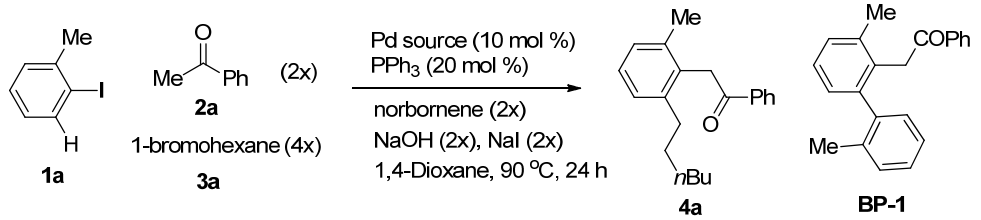
entry	base	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	No base	0	0	0
2	Li_2CO_3	1	0	0
3	Na_2CO_3	6	0	0
4	K_2CO_3	31	0	0
5	Cs_2CO_3	47	8	0
6	NaOAc	6	0	0
7	**NaOH**	**90**	**58**	**0**
8	KOH	71	32	0
9	$CsOH{\cdot}H_2O$	77	30	0
10	NaOMe	100	3	0
11	KOMe	69	1	0
12	NaO*t*Bu	76	4	0
13	KO*t*Bu	46	1	0
14	LiHMDS	29	0	0
15	NaHMDS	49	0	0
16	KHMDS	80	12	0
17	K_3PO_4	41	10	0
18	DIPEA	65	0	0

Table S2. The effect of solvents in a model reaction of acetophenone using PPh_3 as ligand



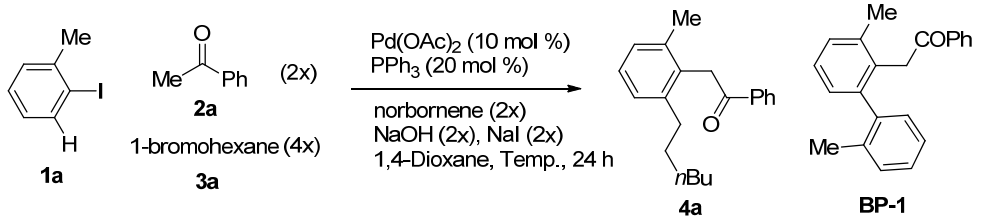
entry	solvent	conv. Of ArI (%)	**4a** (%)	**BP-1** (%)
1	**1,4-Dioxane**	**100**	**64**	**9**
2	THF	82	56	1
3	DME	86	52	0
4	Diglyme	90	58	0
5	Triglyme	76	36	0
6	Anisole	100	3	14
7	Toluene	100	0	17
8	MeCN	66	0	0
9	DMF	58	15	0
10	DMA	45	9	0
11	NMP	71	7	0

Table S3. The effect of palladium catalyst source in a model reaction of acetophenone using PPh_3 as ligand



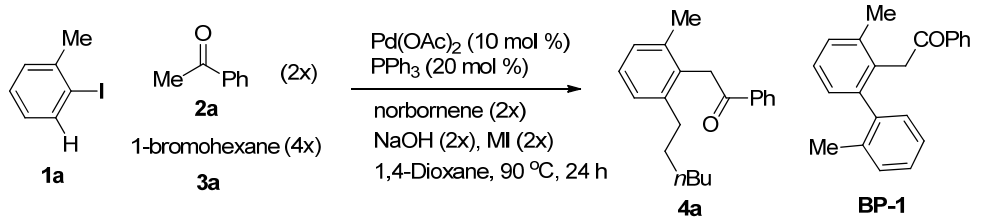
entry	Pd Cat.	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	$Pd_2(dba)_3$	100	5	3
2	$Pd(dba)_2$	100	4	2
3	**$Pd(OAc)_2$**	**100**	**64**	**9**
4	$Pd(TFA)_2$	100	35	6
5	$PdCl_2$	100	49	5
6	PdI_2	100	38	11
7	$Pd(hfacac)_2$	100	55	9
8	$Pd(TMEDA)Me_2$	100	37	1

Table S4. The effect of reaction temperature in a model reaction of acetophenone



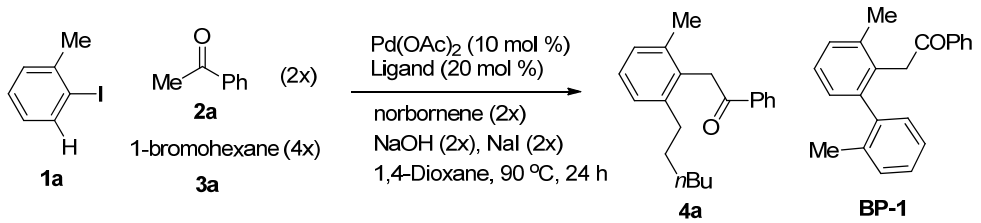
entry	temp. (°C)	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	70	92	55	3
2	**90**	**100**	**64**	**9**
3	110	100	7	7

Table S5. The effect of iodide salts in a model reaction of acetophenone using PPh_3 ligand



entry	MI	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	No iodide salt	100	58	10
2	**NaI**	**100**	**64**	**9**
3	LiI	80	5	0
4	KI	100	61	8
5	*n*-Bu_4NI	85	17	0

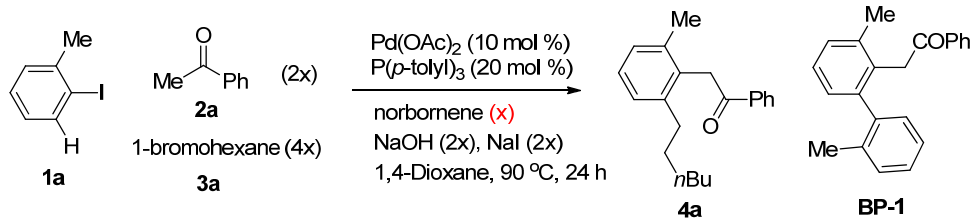
Table S6. The effect of supporting ligands in a model reaction of acetophenone



entry	ligand	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	PPh_3	100	64	9
2	P(2-furyl)$_3$	100	49	8
3	P(2-thienly)$_3$	100	65	7
4	**P(*p*-tolyl)$_3$**	**100**	**70**	**7**
5	P(*m*-tolyl)$_3$	100	60	10
6	P(*p*-anisyl)$_3$	100	43	2
7	P(*m*-anisyl)$_3$	100	60	10
8	P(*o*-anisyl)$_3$	100	65	2
9	P(4-Cl-Ph)$_3$	100	43	9
10	P(4-F-Ph)$_3$	100	57	11

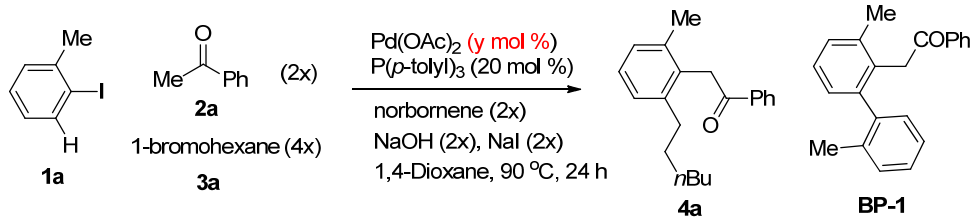
11	JohnPhos	98	25	0
12	XPhos	100	0	0
13	MePhos	100	0	0
14	P(*t*-Bu)$_2$Me	100	4	0
15	PCy$_3$	70	23	0
16	DPPF	100	7	0
17	DPPP	47	11	0
18	DPPE	10	5	0
19	BINAP	100	29	2

Table S7. The effect of norbornene equivalents in a model reaction of acetophenone



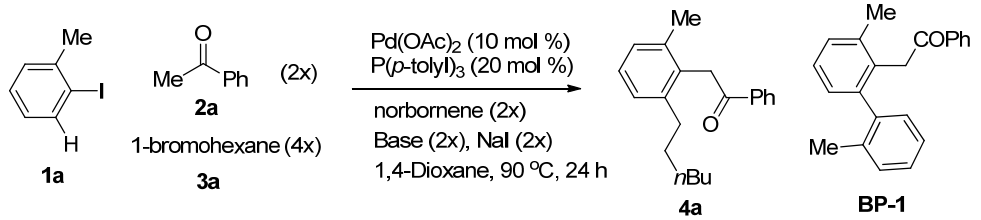
entry	norbornene (equiv.)	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	1	100	59	12
2	**2**	**100**	**70**	**7**
3	3	100	64	6
4	4	100	65	5

Table S8. The effect of palladium loading in a model reaction of acetophenone



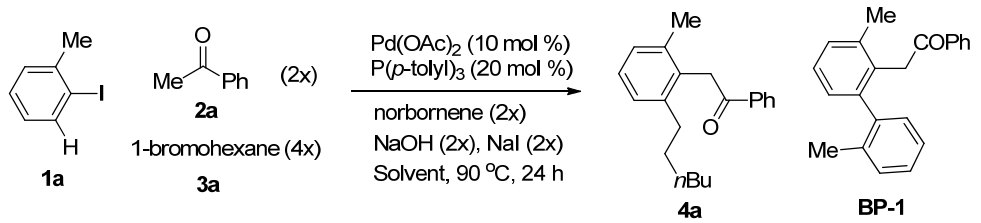
entry	Pd(OAc)$_2$ (mol%)	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	5	100	48	7
2	**10**	**100**	**70**	**7**

Table S9. The effect of bases in a model reaction of acetophenone using P(*p*-tolyl)$_3$ as ligand



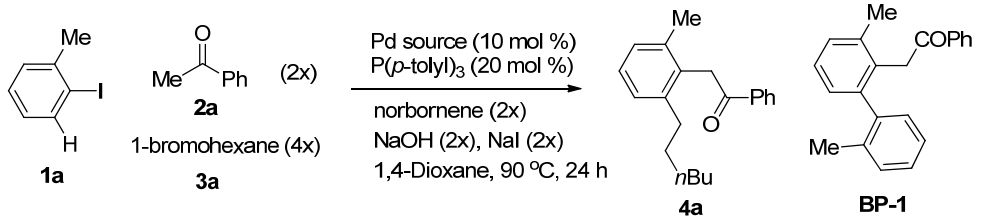
entry	base	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	No base	27	0	0
2	Na_2CO_3	32	0	0
3	Cs_2CO_3	69	4	2
4	**NaOH**	**100**	**70**	**7**
5	KOH	100	38	7
6	$CsOH{\cdot}H_2O$	100	41	5
7	NaOMe	100	0	0
8	KOMe	100	0	0
9	NaO*t*Bu	100	27	2
10	LiO*t*Bu	100	0	0
11	LiHMDS	100	0	0
12	NaHMDS	100	5	0
13	KHMDS	100	17	0
14	K_3PO_4	95	0	0

Table S10. The effect of solvents in a model reaction of acetophenone using P(*p*-tolyl)$_3$ as ligand



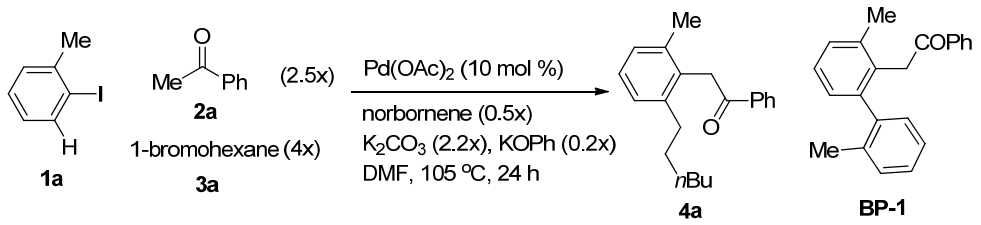
entry	solvent	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	**1,4-Dioxane**	**100**	**70**	**7**
2	THF	96	49	4
3	Diglyme	86	45	0
4	Toluene	100	0	0
5	MeCN	72	0	0
6	DMF	75	13	0
7	DMSO	32	0	0
8	nBuOH	100	0	0
9	DCE	54	0	0

Table S11. The effect of palladium catalyst source in a model reaction of acetophenone using P(*p*-tolyl)$_3$ as ligand



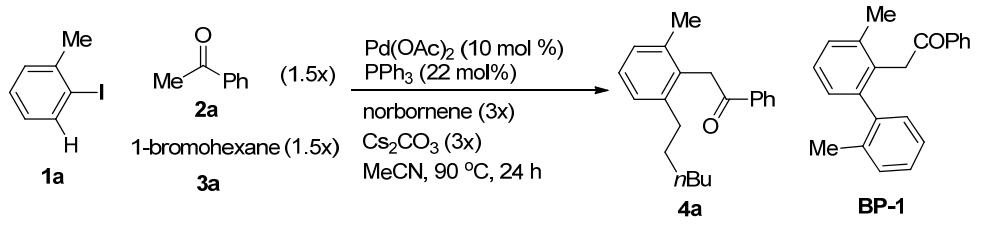
entry	Pd Cat.	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	$Pd(dba)_2$	100	18	2
2	**$Pd(OAc)_2$**	**100**	**70**	**7**
3	$Pd(TFA)_2$	100	33	2
4	$PdCl_2$	100	4	1
5	$PdBr_2$	100	46	3
6	PdI_2	100	45	3
7	$Pd(acac)_2$	100	52	3
8	$Pd(hfacac)_2$	100	27	5

Table S12. Ketone coupling under conditions of Catellani's procedure (*cf:* Maestri, G; Della Ca', N; Catellani, M. *Chem. Commun.*, **2009**, 4892–4894)



entry	conditions	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	No change	31	0	0
2	Additional NaI (2 equiv)	29	0	0
3	P(*p*-tolyl)$_3$ (20 mol%) as ligand	58	0	0
4	P(*p*-tolyl)$_3$ (20 mol%) and NaI (2 equiv)	39	0	0

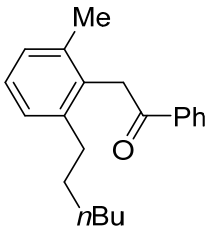
Table S13. Ketone coupling under conditions of Lautens' procedure (*cf:* Zhao, Y.-B.; Mariampillai, B.; Candito, D. A.; Laleu, B.; Li, M.; Lautens, M. *Angew. Chem. Int. Ed.*, **2009**, *48*, 1849-1852)



entry	conditions	conv. of ArI (%)	**4a** (%)	**BP-1** (%)
1	No change	92	14	0
2	Additional NaI (2 equiv.)	71	8	0

III. Procedure for couplings of ketones and characterization of products

A typical procedure for aromatic ketone coupling: In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with $Pd(OAc)_2$ (10 mol%, 4.4 mg, 0.02 mmol), P(*p*-tolyl)$_3$ (20 mol%, 12.2 mg, 0.04 mmol) and dry 1,4-dioxane (2 mL). After stirring for about 10 min at room temperature, *o*-iodotoluene (44 mg, 0.2 mmol), 1-bromohexane (132 mg, 0.8 mmol), norbornene (38 mg, 0.4 mmol), dry NaOH powder (16 mg, 0.4 mmol), NaI (60 mg, 0.4 mmol), acetophenone (48 mg, 0.4 mmol) and GC standard *n*-dodecane (20 μL) were added sequentially. For reactions using alkyl iodides, NaI was not added. The tube was capped tightly and the reaction mixture was heated at 90 ^oC for 24 h. At the end of reaction, the mixture was cooled to rt. The desired products were purified by flash chromatography over silica gel using 20:1 hexanes/EA.



2-(2-*n*-Hexyl-6-tolyl)acetophenone (4a).

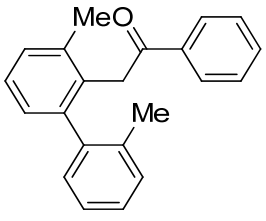
Yellow oil. 41 mg, 69% yield.

^1H NMR (400 MHz, $CDCl_3$): δ 8.11 – 8.09 (m, 2H), 7.64 – 7.61 (m, 1H), 7.53 (ψt, *J* = 7.6 Hz, 2H), 7.18 – 7.14 (m, 1H), 7.10 – 7.08 (m, 2H), 4.41 (s, 2H), 2.55 – 2.51 (m, 2H), 2.22 (s, 3H), 1.58 – 1.48 (m, 2H), 1.34 – 1.21 (m, 6H), 0.84 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.3, 141.7, 137.5, 137.3, 133.3, 131.9, 128.8, 128.2, 128.1, 127.2, 127.1, 39.3, 34.1, 31.8, 31.1, 29.4, 22.7, 20.6, 14.2.

GCMS (EI): Calcd for $C_{21}H_{26}O$: 294.2, found: 294.2.

HRMS (ESI): Calcd for $C_{21}H_{26}O$ $[M+H]^+$ 295.2062, found: 295.2069.



2-(3,2'-Dimethyl-1,1'-biphenyl-2-yl)acetophenone (BP-1).

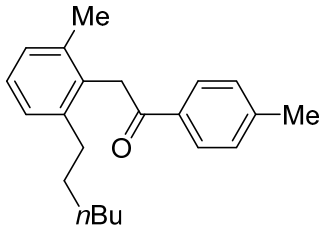
Yellow oil. 19 mg, 32% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80 – 7.78 (m, 2H), 7.55 – 7.51 (m, 1H), 7.42 – 7.38 (m, 2H), 7.29 – 7.27 (m, 2H), 7.22 – 7.16 (m, 2H), 7.13 – 7.05 (m, 3H), 4.12 (dd, *J* = 91.7, 17.7 Hz, 2H), 2.29 (s, 3H), 2.08 (s, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.4, 142.4, 141.4, 137.7, 137.1, 136.0, 132.8, 132.1, 129.9, 129.5, 129.2, 128.4, 127.9, 127.29, 127.27, 126.7, 125.5, 40.4, 20.4, 20.1.

GCMS (EI): Calcd for $C_{22}H_{20}O$: 300.2, found: 300.1.

HRMS (ESI): Calcd for $C_{22}H_{20}O$ $[M+H]^+$ 301.1592, found: 301.1591.



2-(2-*n*-Hexyl-6-tolyl)-4'-methylacetophenone (4b).

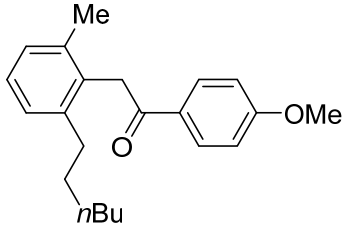
Yellow oil. 36 mg, 58% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 8.00 (d, *J* = 8.2 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.17 – 7.12 (m, 1H), 7.08 – 7.06 (m, 2H), 4.37 (s, 2H), 2.54 – 2.49 (m, 2H), 2.45 (s, 3H), 2.21 (s, 3H), 1.57 – 1.46 (m, 2H), 1.29 – 1.21 (m, 6H), 0.84 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 196.8, 143.9, 141.6, 137.4, 134.7, 132.0, 129.4, 128.2, 127.9, 127.1, 126.9, 39.0, 33.9, 31.7, 31.0, 29.3, 22.6, 21.7, 20.5, 14.1.

GCMS (EI): Calcd for $C_{22}H_{28}O$: 308.2, found: 308.2.

HRMS (ESI): Calcd for $C_{22}H_{28}O$ $[M+H]^+$ 309.2218, found: 309.2222.



2-(2-*n*-Hexyl-6-tolyl)-4'-methoxyacetophenone (4c).

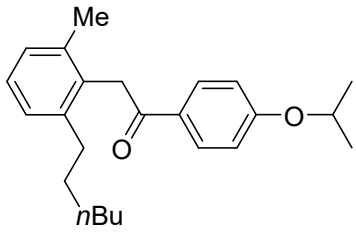
Yellow oil. 40 mg, 62% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 – 8.05 (m, 2H), 7.13 (dd, *J* = 7.9, 7.0 Hz, 1H), 7.07 – 7.05 (m, 2H), 7.01 – 6.97 (m, 2H), 4.34 (s, 2H), 3.90 (s, 3H), 2.53 – 2.49 (m, 2H), 2.20 (s, 3H), 1.54 – 1.46 (m, 2H), 1.31 – 1.21 (m, 6H), 0.83 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 195.7, 163.5, 141.6, 137.4, 132.1, 130.3, 130.2, 127.9, 127.1, 126.8, 113.8, 55.5, 38.7, 33.9, 31.7, 31.0, 29.3, 22.6, 20.5, 14.1.

GCMS (EI): Calcd for $C_{22}H_{28}O_2$: 324.2, found: 324.0.

HRMS (ESI): Calcd for $C_{22}H_{28}O_2$ $[M+H]^+$ 325.2168, found: 325.2169.



2-(2-*n*-Hexyl-6-tolyl)-4'-isopropoxyacetophenone (4d).

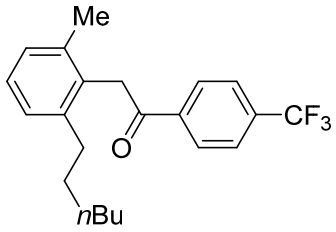
Yellow oil. 42 mg, 60% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.07 – 8.03 (m, 2H), 7.13 (dd, *J* = 7.9, 7.0 Hz, 1H), 7.07 – 7.05 (m, 2H), 6.97 – 6.94 (m, 2H), 4.68 (hept, *J* = 6.1 Hz, 1H), 4.34 (s, 2H), 2.53 – 2.49 (m, 2H), 2.21 (s, 3H), 1.52 – 1.47 (m, 2H), 1.39 (d, *J* = 6.1 Hz, 6H), 1.29 – 1.22 (m, 6H), 0.83 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 195.6, 162.1, 141.6, 137.4, 132.1, 130.4, 129.8, 127.9, 127.1, 126.8, 115.2, 70.1, 38.7, 33.9, 31.7, 31.0, 29.3, 22.6, 21.9, 20.5, 14.1.

GCMS (EI): Calcd for $C_{24}H_{32}O_2$: 352.2, found: 352.2.

HRMS (ESI): Calcd for $C_{24}H_{32}O_2$ $[M+H]^+$ 353.2481, found: 353.2481.



2-(2-*n*-Hexyl-6-tolyl)-(4'-trifluoromethyl)acetophenone (4e).

Yellow oil. 44 mg, 61% yield.

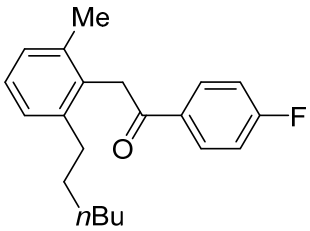
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.18 (d, *J* = 8.1 Hz, 2H), 7.79 (d, *J* = 8.2 Hz, 2H), 7.18 – 7.14 (m, 1H), 7.09 – 7.07 (m, 2H), 4.40 (s, 2H), 2.52 – 2.48 (m, 2H), 2.20 (s, 3H), 1.53 – 1.46 (m, 2H), 1.31 – 1.22 (m, 6H), 0.83 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 196.3, 141.5, 139.8, 137.2, 134.6 (q, $J_{C\text{-}F}$ = 32.9 Hz), 131.1, 128.4, 128.1, 127.24, 127.19, 125.8 (q, $J_{C\text{-}F}$ = 3.7 Hz), 123.6(q, $J_{C\text{-}F}$ = 272.4 Hz), 39.5, 33.9, 31.7, 31.0, 29.3, 22.5, 20.5, 14.0.

^{19}F $\{^1$H$\}$ NMR (376 MHz, $CDCl_3$) δ: -63.1.

GCMS (EI): Calcd for $C_{22}H_{25}F_3O$: 362.2, found: 362.1.

HRMS (ESI): Calcd for $C_{22}H_{25}F_3O$ $[M+H]^+$ 363.1936, found: 363.1935.



1-(4-Fluorophenyl)-2-(2-*n*-hexyl-6-methylphenyl)ethan-1-one (4f).

Yellow oil. 48 mg, 76% yield.

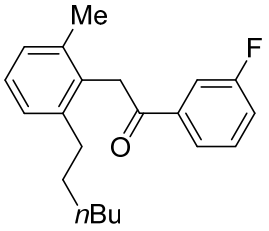
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 – 8.10 (m, 2H), 7.19 (ψt, *J* = 8.6 Hz, 2H), 7.14 (d, *J* = 7.1 Hz, 1H), 7.07 (d, *J* = 7.6 Hz, 2H), 4.36 (s, 2H), 2.52 – 2.48 (m, 2H), 2.20 (s, 3H), 1.54 – 1.46 (m, 2H), 1.33 – 1.22 (m, 6H), 0.83 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 195.7, 166.0 (d, $J_{C\text{-}F}$ = 254.7 Hz), 141.7, 137.4, 133.7 (d, $J_{C\text{-}F}$ = 3.0 Hz), 131.7, 130.8 (d, $J_{C\text{-}F}$ = 9.3 Hz), 128.1, 127.3, 127.2, 115.9 (d, $J_{C\text{-}F}$ = 21.8 Hz), 39.2, 34.1, 31.8, 31.1, 29.4, 22.7, 20.6, 14.2.

^{19}F {^{1}H} NMR (376 MHz, $CDCl_3$): δ -105.2.

GCMS (EI): Calcd for $C_{21}H_{25}FO$: 312.2, found: 312.2.

HRMS (ESI): Calcd for $C_{21}H_{25}FO$ $[M+H]^+$ 313.1968, found: 313.1969.



2-(2-*n*-Hexyl-6-tolyl)-3'-fluoroacetophenone (4g).

Yellow oil. 41 mg, 65% yield.

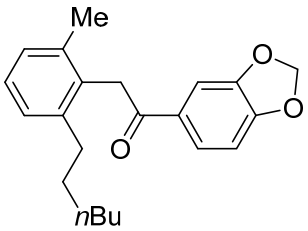
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.89 – 7.87 (m, 1H), 7.77 – 7.73 (m, 1H), 7.54 – 7.48 (m, 1H), 7.34 – 7.29 (m, *J* = 8.3, 2.6, 0.9 Hz, 1H), 7.15 (dd, *J* = 8.0, 7.0 Hz, 1H), 7.09 – 7.07 (m, 2H), 4.37 (s, 2H), 2.52 – 2.48 (m, 2H), 2.20 (s, 3H), 1.56 – 1.46 (m, 2H), 1.31 – 1.21 (m, 6H), 0.83 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 196.0 (d, $J_{C\text{-}F}$ = 2.1 Hz), 163.0 (d, $J_{C\text{-}F}$ = 248.1 Hz), 141.5, 139.2 (d, $J_{C\text{-}F}$ = 6.1 Hz), 137.3, 131.3, 130.4 (d, $J_{C\text{-}F}$ = 7.6 Hz), 128.0, 127.1 (d, $J_{C\text{-}F}$ = 8.9 Hz), 123.8 (d, $J_{C\text{-}F}$ = 3.0 Hz), 120.2 (d, $J_{C\text{-}F}$ = 21.5 Hz), 114.9 (d, $J_{C\text{-}F}$ = 22.2 Hz), 39.3, 33.9, 31.7, 31.0, 29.3, 22.6, 20.5, 14.0.

^{19}F {^{1}H} NMR (376 MHz, $CDCl_3$) δ: -111.6.

GCMS (EI): Calcd for $C_{21}H_{25}FO$: 312.2, found: 312.1.

HRMS (ESI): Calcd for $C_{21}H_{25}FO$ $[M+H]^+$ 313.1968, found: 313.1973.



2-(2-*n*-Hexyl-6-tolyl)-5-aceto-1,3-benzodioxole (4h).

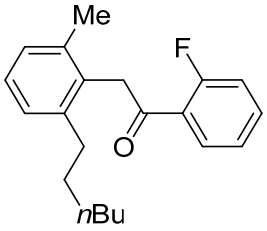
Yellow oil. 45 mg, 67% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.72 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.54 (d, *J* = 1.7 Hz, 1H), 7.15 – 7.12 (m, 1H), 7.06 (d, *J* = 7.7 Hz, 2H), 6.91 (ψd, *J* = 8.2 Hz, 1H), 6.07 (s, 2H), 4.31 (s, 2H), 2.52 – 2.48 (m, 2H), 2.20 (s, 3H), 1.52 – 1.46 (m, 2H), 1.33 – 1.22 (m, 6H), 0.84 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 195.2, 151.8, 148.3, 141.6, 137.3, 132.0, 131.9, 127.9, 127.1, 126.9, 124.2, 108.02, 107.95, 101.9, 38.8, 33.9, 31.7, 31.0, 29.3, 22.6, 20.5, 14.1.

GCMS (EI): Calcd for $C_{22}H_{26}O_3$: 338.2, found: 338.2.

HRMS (ESI): Calcd for $C_{22}H_{26}O_3$ $[M+H]^+$ 339.1960, found: 339.1958.



1-(2-Fluorophenyl)-2-(2-*n*-hexyl-6-methylphenyl)ethan-1-one (4i).

Yellow oil. 48 mg, 77% yield.

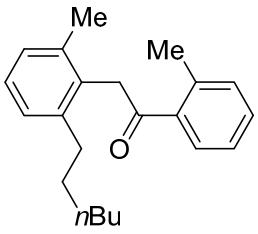
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87 (td, *J* = 7.6, 1.8 Hz, 1H), 7.59 – 7.54 (m, 1H), 7.29 – 7.27 (m, 1H), 7.25 – 7.19 (m, 1H), 7.16 – 7.13 (m, 1H), 7.08 – 7.06 (m, 2H), 4.39 (d, *J* = 2.5 Hz, 2H), 2.54 – 2.50 (m, 2H), 2.22 (s, 3H), 1.55 – 1.47 (m, 2H), 1.34 – 1.22 (m, 6H), 0.84 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 196.1 (d, $J_{C\text{-}F}$ = 4.8 Hz), 162.1 (d, $J_{C\text{-}F}$= 253.6 Hz), 141.7, 137.5, 134.6 (d, $J_{C\text{-}F}$= 8.8 Hz), 131.7 (d, $J_{C\text{-}F}$ = 1.4 Hz), 130.9 (d, $J_{C\text{-}F}$ = 2.9 Hz), 128.1, 127.2, 127.1, 126.2 (d, $J_{C\text{-}F}$ = 13.8 Hz), 124.8 (d, $J_{C\text{-}F}$ = 3.2 Hz), 116.9 (d, $J_{C\text{-}F}$ = 24.0 Hz), 44.2 (d, $J_{C\text{-}F}$ = 8.3 Hz), 34.1, 31.8, 31.1, 29.4, 22.7, 20.6, 14.2.

^{19}F {^{1}H} NMR (376 MHz, $CDCl_3$): δ -108.9.

GCMS (EI): Calcd for $C_{21}H_{25}FO$: 312.2, found: 312.1.

HRMS (ESI): Calcd for $C_{21}H_{25}FO$ $[M+H]^+$ 313.1968, found: 313.1971.



2-(2-*n*-Hexyl-6-tolyl)-2'-methylacetophenone (4j).

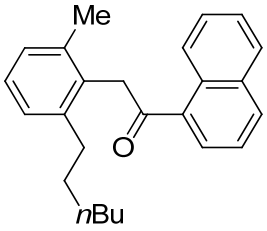
Yellow oil. 43 mg, 70% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81 (d, *J* = 7.7Hz, 1H), 7.42 (ψtd, *J* = 7.5, 1.3 Hz, 1H), 7.34 – 7.28 (m, 2H), 7.15 (dd, *J* = 8.3, 6.6 Hz, 1H), 7.08 (ψd, *J* = 7.6 Hz, 2H), 4.32 (s, 2H), 2.56 – 2.52 (m, 2H), 2.49 (s, 3H), 2.24 (s, 3H), 1.56 – 1.50 (m, 2H), 1.34 – 1.24 (m, 6H), 0.85 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.3, 141.6, 138.3, 138.1, 137.3, 132.1, 131.7, 131.3, 128.04, 128.01, 127.2, 127.0, 125.8, 42.2, 33.9, 31.7, 31.0, 29.4, 22.6, 21.2, 20.5, 14.1.

GCMS (EI): Calcd for $C_{22}H_{28}O$: 308.2, found: 308.1.

HRMS (ESI): Calcd for $C_{22}H_{28}O$ $[M+H]^+$ 309.2218, found: 309.2220.



2-(2-*n*-Hexyl-6-methylphenyl)-1-(naphthalen-1-yl)ethan-1-one (4k).

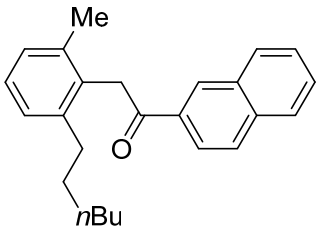
Yellow solid. 39 mg, 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.57 – 8.54 (m, 1H), 8.02 (ψt, *J* = 7.5 Hz, 2H), 7.90 – 7.87 (m, 1H), 7.58 – 7.51 (m, 3H), 7.18 – 7.15 (m, 1H), 7.11 – 7.09 (m, 2H), 4.48 (s, 2H), 2.60 – 2.56 (m, 2H), 2.29 (s, 3H), 1.58 – 1.50 (m, 2H), 1.33 – 1.20 (m, 6H), 0.81 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.5, 141.8, 137.5, 136.4, 134.2, 132.8, 132.0, 130.3, 128.6, 128.2, 128.1, 127.4, 127.20, 127.17, 126.7, 125.8, 124.5, 42.9, 34.2, 31.8, 31.2, 29.5, 22.7, 20.7, 14.2.

GCMS (EI): Calcd for $C_{25}H_{28}O$: 344.2, found: 344.2

HRMS (ESI): Calcd for $C_{25}H_{28}O$ $[M+H]^+$ 345.2218, found: 345.2222.



2-(2-*n*-Hexyl-6-tolyl)acetonaphth-2-one (4l).

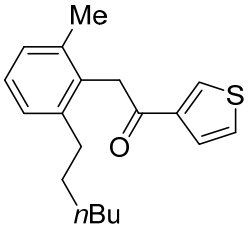
Yellow oil. 43 mg, 63% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.64 (s, 1H), 8.13 (dd, *J* = 8.6, 1.7 Hz, 1H), 8.03 (d, *J* = 7.9 Hz, 1H), 7.93 (dd, *J* = 12.7, 8.4 Hz, 2H), 7.61 (ψdt, *J* = 14.7, 6.9 Hz, 2H), 7.18 – 7.15 (m, 1H), 7.09 (d, *J* = 7.7 Hz, 2H), 4.54 (s, 2H), 2.57 – 2.53 (m, 2H), 2.25 (s, 3H), 1.57 – 1.50 (m, 2H), 1.31 – 1.20 (m, 6H), 0.80 (t, *J* = 6.9 Hz, 3H)..

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.1, 141.6, 137.4, 135.7, 134.5, 132.6, 131.9, 129.6, 129.5, 128.6, 128.5, 128.0, 127.8, 127.2, 127.0, 126.9, 124.0, 39.2, 34.0, 31.7, 31.0, 29.3, 22.6, 20.6, 14.0.

GCMS (EI): Calcd for $C_{25}H_{28}O$: 344.2, found: 344.1.

HRMS (ESI): Calcd for $C_{25}H_{28}O$ $[M+H]^+$ 345.2218, found: 345.2214.



2-(2-*n*-Hexyl-6-tolyl)aceto-3-thiophene (4m).

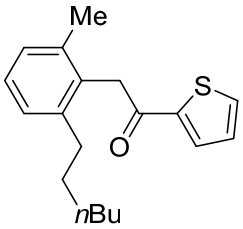
Yellow oil. 34 mg, 56% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.15 (dd, *J* = 2.9, 1.3 Hz, 1H), 7.62 (dd, *J* = 5.1, 1.2 Hz, 1H), 7.36 (dd, *J* = 5.1, 2.9 Hz, 1H), 7.16 – 7.12 (m, 1H), 7.07 – 7.05 (m, 2H), 4.29 (s, 2H), 2.55 – 2.51 (m, 2H), 2.22 (s, 3H), 1.54 – 1.47 (m, 2H), 1.34 – 1.22 (m, 6H), 0.84 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 191.6, 142.2, 141.6, 137.4, 131.8, 131.5, 128.0, 127.2, 127.1, 127.0, 126.4, 40.5, 33.9, 31.7, 31.0, 29.3, 22.6, 20.6, 14.1.

GCMS (EI): Calcd for $C_{19}H_{24}OS$: 300.2, found: 300.1.

HRMS (ESI): Calcd for $C_{19}H_{24}OS$ $[M+H]^+$ 301.1626, found: 301.1623.



2-(2-*n*-Hexyl-6-tolyl)aceto-2-thiophene (4n).

Yellow oil. 28 mg, 47% yield.

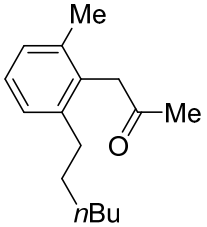
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82 (dd, *J* = 3.8, 1.0 Hz, 1H), 7.66 (dd, *J* = 5.0, 1.0 Hz, 1H), 7.18 – 7.12 (m, 2H), 7.07 – 7.05 (m, 2H), 4.32 (s, 2H), 2.58 – 2.54 (m, 2H), 2.25 (s, 3H), 1.54 – 1.48 (m, 2H), 1.35 – 1.22 (m, 6H), 0.84 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 190.2, 144.1, 141.7, 137.5, 133.5, 131.7, 131.3, 128.1, 128.0, 127.2, 127.1, 40.0, 34.0, 31.7, 31.0, 29.3, 22.6, 20.6, 14.1.

GCMS (EI): Calcd for $C_{19}H_{24}OS$: 300.2, found: 300.0.

HRMS (ESI): Calcd for $C_{19}H_{24}OS$ $[M+H]^+$ 301.1626, found: 301.1628.

A typical procedure for aliphatic ketone coupling: In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with $Pd(OAc)_2$ (10 mol%, 4.4 mg, 0.02 mmol), P(*p*-tolyl)$_3$ (20 mol%, 12 mg, 0.04 mmol) and dry 1,4-dioxane (2 mL). After stirring for about 10 min at room temperature, *o*-iodotoluene (44 mg, 0.2 mmol), 1-bromohexane (132 mg, 0.8 mmol), norbornene (38 mg, 0.4 mmol), dry NaOH powder (32 mg, 0.8 mmol), NaI (60 mg, 0.4 mmol), acetone (58 mg, 1 mmol) and GC standard *n*-dodecane (20 μL) were added sequentially. For reactions using alkyl iodides, NaI was not added. The tube was capped tightly and the reaction mixture was heated at 90 ^{o}C for 24 h. At the end of reaction, the mixture was cooled to rt. The desired products were purified by flash chromatography over silica gel using 20:1 hexanes/EA.



1-(2-*n*-Hexyl-6-tolyl)acetone (4o).

Yellow oil. 34 mg, 73% yield.

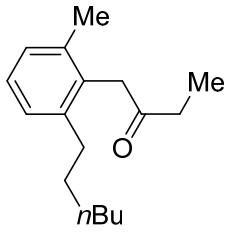
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.14 –7.10 (m, 1H), 7.06 – 7.04 (m, 2H), 3.79 (s, 2H), 2.55 – 2.51 (m, 2H), 2.23 (s, 3H), 2.16 (s, 3H), 1.55 – 1.47 (m, 2H), 1.39 – 1.26 (m, 6H), 0.89 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 206.6, 141.5, 137.1, 131.5, 128.2, 127.3, 127.0, 44.7, 33.8, 31.7, 31.0, 29.43, 29.39, 22.6, 20.5,

14.1.

GCMS (EI): Calcd for $C_{16}H_{24}O$: 232.2, found: 232.0.

HRMS (ESI): Calcd for $C_{16}H_{24}O$ $[M+H]^+$ 233.1905, found: 233.1902.



1-(2-*n*-Hexyl-6-tolyl)-2-butanone (4p).

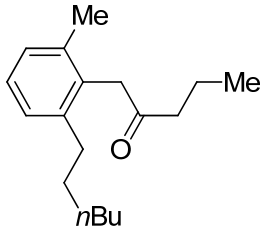
Yellow oil. 20 mg, 41% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.13 – 7.09 (m, 1H), 7.05 – 7.03 (m, 2H), 3.77 (s, 2H), 2.54 – 2.50 (m, 2H), 2.44 (q, *J* = 7.3 Hz, 2H), 2.22 (s, 3H), 1.54 – 1.46 (m, 2H), 1.35 – 1.26 (m, 6H), 1.06 (t, *J* = 7.3 Hz, 3H), 0.89 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 209.1, 141.5, 137.1, 131.7, 128.1, 127.2, 126.9, 43.6, 35.2, 33.8, 31.7, 31.0, 29.4, 22.6, 20.5, 14.1, 7.9.

GCMS (EI): Calcd for $C_{17}H_{26}O$: 246.2, found: 246.0.

HRMS (ESI): Calcd for $C_{17}H_{26}O$ $[M+H]^+$ 247.2062, found: 247.2077.



1-(2-*n*-Hexyl-6-tolyl)pentan-2-one (4q).

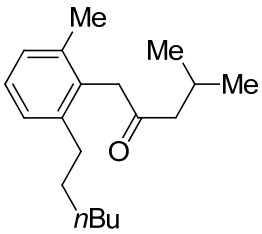
Yellow oil. 26 mg, 49% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.13 – 7.09 (m, 1H), 7.05 – 7.03 (m, 2H), 3.77 (s, 2H), 2.54 – 2.50 (m, 2H), 2.41 (t, *J* = 7.3 Hz, 2H), 2.21 (s, 3H), 1.67 – 1.60 (m, 2H), 1.54 – 1.47 (m, 2H), 1.33 – 1.26 (m, 6H), 0.93 – 0.87 (m, 6H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 208.5, 141.5, 137.1, 131.6, 128.1, 127.2, 126.9, 44.01, 43.98, 33.8, 31.7, 31.0, 29.4, 22.6, 20.5, 17.4, 14.1, 13.7.

GCMS (EI): Calcd for $C_{18}H_{28}O$: 260.2, found: 260.1.

HRMS (ESI): Calcd for $C_{18}H_{28}O$ $[M+H]^+$ 261.2218, found: 261.2222.



1-(2-*n*-Hexyl-6-tolyl)-4-methyl-2-pentanone (4r).

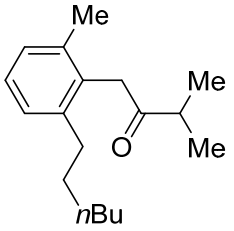
Yellow oil. 23 mg, 42% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.13 – 7.09 (m, 1H), 7.05 – 7.02 (m, 2H), 3.75 (s, 2H), 2.53 – 2.49 (m, 2H), 2.32 (d, *J* = 6.9 Hz, 2H), 2.20 (s, 3H), 2.18 – 2.15 (m, 1H), 1.52 – 1.46 (m, 2H), 1.33 – 1.26 (m, 6H), 0.92 (d, *J* = 6.6 Hz, 6H), 0.88 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 207.9, 141.5, 137.1, 131.5, 128.1, 127.2, 126.9, 51.1, 44.5, 33.8, 31.7, 31.0, 29.4, 24.5, 22.6, 22.6, 20.5, 14.0.

GCMS (EI): Calcd for $C_{19}H_{30}O$: 274.2, found: 274.1.

HRMS (ESI): Calcd for $C_{19}H_{30}O$ $[M+H]^+$ 275.2375, found: 275.2374



1-(2-*n*-Hexyl-6-tolyl)-3-methylbutanone (4s).

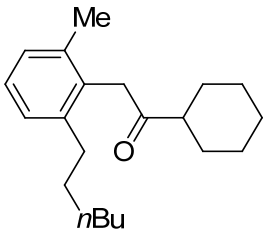
Yellow oil. 26 mg, 49% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.12 – 7.09 (m, 1H), 7.04 – 7.02 (m, 2H), 3.85 (s, 2H), 2.82 – 2.71 (m, 1H), 2.51 – 2.47 (m, 2H), 2.19 (s, 3H), 1.53 – 1.44 (m, 2H), 1.37 – 1.27 (m, 6H), 1.17 (d, *J* = 6.9 Hz, 6H), 0.89 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 211.8, 141.5, 137.2, 131.5, 128.0, 127.1, 126.8, 41.5, 40.4, 33.8, 31.7, 31.0, 29.4, 22.6, 20.4, 18.7, 14.1.

GCMS (EI): Calcd for $C_{18}H_{28}O$: 260.2, found: 260.0.

HRMS (ESI): Calcd for $C_{18}H_{28}O$ $[M+H]^+$ 261.2218, found: 261.2216.



1-(2-*n*-Hexyl-6-tolyl)acetocyclohexane (4t).

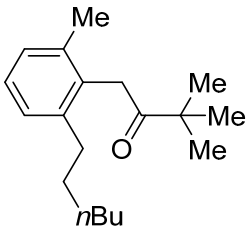
Yellow oil. 27 mg, 45% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.11 – 7.08 (m, 1H), 7.03 – 7.01 (m, 2H), 3.83 (s, 2H), 2.49 – 2.45 (m, 2H), 2.17 (s, 3H), 1.90-1.80 (m, 4H), 1.69 (d, J = 9.5 Hz, 1H), 1.52 – 1.43 (m, 4H), 1.34 – 1.26 (m, 10H), 0.88 (t, J = 6.1 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 210.9, 141.4, 137.1, 131.5, 127.9, 127.1, 126.8, 50.6, 41.6, 33.8, 31.7, 31.0, 29.4, 28.9, 25.8, 25.7, 22.6, 20.4, 14.1.

GCMS (EI): Calcd for $C_{21}H_{32}O$: 300.2, found: 300.1.

HRMS (ESI): Calcd for $C_{21}H_{32}O$ $[M+H]^+$ 301.2531, found: 301.2529.



1-(2-*n*-Hexyl-6-tolyl)-3,3-dimethylbutanone (4u).

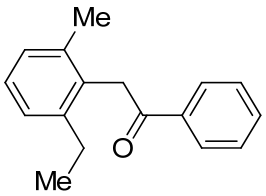
Yellow oil. 28 mg, 51% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.11 – 7.07 (m, 1H), 7.03 – 7.01 (m, 2H), 3.93 (s, 2H), 2.45 – 2.41 (m, 2H), 2.13 (s, 3H), 1.50 – 1.46 (m, 2H), 1.35 – 1.34 (m, 6H), 1.29 (s, 9H), 0.88 (t, J = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 212.3, 141.4, 137.1, 131.8, 127.8, 127.0, 126.7, 44.5, 37.3, 33.8, 31.7, 31.0, 29.4, 27.0, 22.6, 20.2, 14.1.

GCMS (EI): Calcd for $C_{19}H_{30}O$: 274.2, found: 274.1.

HRMS (ESI): Calcd for $C_{19}H_{30}O$ $[M+H]^+$ 275.2375, found: 275.2376



2-(2-Ethyl-6-tolyl)acetophenone (5a).

Ethyl bromide (216 mg, 2 mmol, 10 equiv) was used.

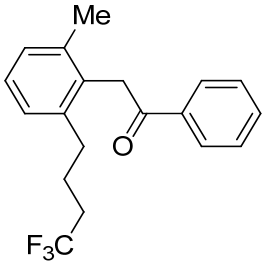
White solid. 34 mg, 71% yield.

^{1}H NMR (400 M1Hz, $CDCl_3$): δ 8.11 – 8.09 (m, 2H), 7.62 (ψt, *J* = 7.4 Hz, 1H), 7.54 – 7.51 (m, 2H), 7.19 – 7.16 (m, 1H), 7.12 – 7.07 (m, 2H), 4.41 (s, 2H), 2.56 (q, *J* = 7.6 Hz, 2H), 2.22 (s, 3H), 1.17 (t, *J* = 7.6 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.1, 142.8, 137.3, 137.1, 133.2, 131.6, 128.7, 128.1, 128.0, 127.1, 126.2, 39.1, 26.7, 20.5, 15.1.

GCMS (EI): Calcd for $C_{17}H_{18}O$: 238.1, found: 238.0.

HRMS (ESI): Calcd for $C_{17}H_{18}O$ $[M+H]^+$ 239.1436, found: 239.1439.



2-[2-(4',4',4'-Trifluorobutyl)-6-tolyl]acetophenone (5b).

Yellow oil. 40 mg, 62% yield.

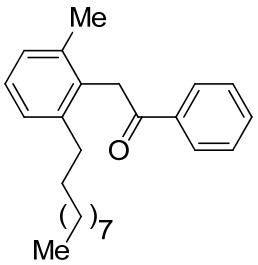
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 – 8.07 (m, 2H), 7.65 – 7.61 (m, 1H), 7.55 – 7.51 (m, 2H), 7.19 – 7.15 (m, 1H), 7.11 (d, *J* = 6.8 Hz, 1H), 7.06 (d, *J* = 7.5 Hz, 1H), 4.39 (s, 2H), 2.64 – 2.60 (m, 2H), 2.21 (s, 3H), 2.12 – 2.00 (m, 2H), 1.84 – 1.76 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.0, 139.5, 137.7, 136.9, 133.4, 131.9, 128.8, 128.6, 128.1, 127.1 (q, $J_{C\text{-}F}$ = 276.5 Hz), 127.2, 127.0, 39.1, 33.2 (q, $J_{C\text{-}F}$ = 28.5 Hz), 32.5, 22.9 (q, $J_{C\text{-}F}$ = 2.8 Hz), 20.5.

^{19}F {^{1}H} NMR (376 MHz, $CDCl_3$): δ -66.1.

GCMS (EI): Calcd for $C_{19}H_{19}F_3O$: 320.1, found: 320.1.

HRMS (ESI): Calcd for $C_{19}H_{19}F_3O$ $[M+H]^+$ 321.1466, found: 321.1467.



2-(2-*n*-Decyl-6-tolyl)acetophenone (5c).

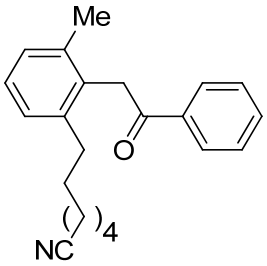
White solid. 40 mg, 57% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 – 8.08 (m, 2H), 7.62 (t, *J* = 7.4 Hz, 1H), 7.54 – 7.50 (m, 2H), 7.17 – 7.13 (m, 1H), 7.08 – 7.06 (m, 2H), 4.40 (s, 2H), 2.53 – 2.49 (m, 2H), 2.21 (s, 3H), 1.55 – 1.47 (m, 2H), 1.29 – 1.21 (m, 14H), 0.88 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.2, 141.6, 137.3, 137.2, 133.2, 131.8, 128.7, 128.1, 128.0, 127.1, 126.9, 39.1, 33.9, 31.9, 31.0, 29.64, 29.60, 29.55, 29.47, 29.3, 22.7, 20.5, 14.1.

GCMS (EI): Calcd for $C_{25}H_{34}O$: 350.3, found: 350.2.

HRMS (ESI): Calcd for $C_{25}H_{34}O$ $[M+H]^+$ 351.2688, found: 351.2683.



2-[2-(6-Cyanohexyl)-6-tolyl]acetophenone (5d).

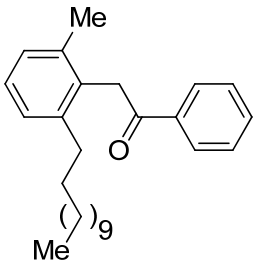
Yellow oil. 49 mg, 77% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 – 8.08 (m, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.53 (m, 2H), 7.17 – 7.13 (m, 1H), 7.09 – 7.05 (m, 2H), 4.40 (s, 2H), 2.56 – 2.52 (m, 2H), 2.25 (t, *J* = 7.1 Hz, 2H), 2.21 (s, 3H), 1.60 – 1.51 (m, 4H), 1.42 – 1.29 (m, 4H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.1, 141.0, 137.5, 137.1, 133.3, 131.8, 128.8, 128.2, 128.1, 127.1, 127.0, 119.8, 39.2, 33.7, 30.5, 28.6, 28.5, 25.2, 20.5, 17.0.

GCMS (EI): Calcd for $C_{22}H_{25}NO$: 319.2, found: 319.1.

HRMS (ESI): Calcd for $C_{22}H_{25}NO$ $[M+H]^+$ 320.2014, found: 320.2017.



2-(2-*n*-Dodecyl-6-tolyl)acetophenone (5e).

1-Iodododecane (237 mg, 0.8 mmol, 4 equiv) was used.

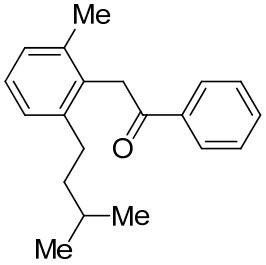
White solid. 47 mg, 62% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 – 8.08 (m, 2H), 7.64 – 7.60 (m, 1H), 7.54 – 7.50 (m, 2H), 7.16 – 7.13 (m, 1H), 7.08 – 7.06 (m, 2H), 4.40 (s, 2H), 2.53 – 2.49 (m, 2H), 2.21 (s, 3H), 1.55 – 1.47 (m, 2H), 1.30 – 1.21 (m, 18H), 0.88 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.2, 141.6, 137.3, 137.2, 133.2, 131.8, 128.7, 128.1, 128.0, 127.1, 126.9, 39.1, 33.9, 31.9, 31.0, 29.6, 29.55, 29.47, 29.4, 22.7, 20.5, 14.1.

GCMS (EI): Calcd for $C_{27}H_{38}O$: 378.3, found: 378.2.

HRMS (ESI): Calcd for $C_{27}H_{38}O$ $[M+H]^+$ 379.3001, found: 379.3001.



2-(2-*i*-Pentyl-6-tolyl)acetophenone (5f).

1-Iodo-3-methylbutane (158 mg, 0.8 mmol, 4 equiv) was used.

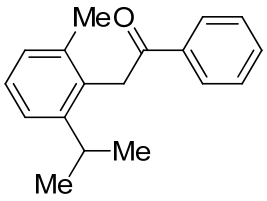
White solid. 38 mg, 68% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 (d, *J* = 7.7 Hz, 2H), 7.61 (t, *J* = 7.3 Hz, 1H), 7.54 – 7.50 (m, 2H), 7.16 – 7.12 (m, 1H), 7.08 – 7.06 (m, 2H), 4.39 (s, 2H), 2.53 – 2.49 (m, 2H), 2.21 (s, 3H), 1.57 – 1.49 (m, 1H), 1.42 – 1.36 (m, 2H), 0.85 (d, *J* = 6.6 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.2, 141.8, 137.4, 137.2, 133.2, 131.7, 128.7, 128.04, 127.95, 127.1, 127.0, 40.4, 39.1, 31.8, 28.1, 22.5, 20.5.

GCMS (EI): Calcd for $C_{20}H_{24}O$: 280.2, found: 280.1.

HRMS (ESI): Calcd for $C_{20}H_{24}O$ $[M+H]^+$ 281.1905, found: 281.1907.



2-(2-*i*-Propyl-6-tolyl)acetophenone (5g).

P(*m*-anisyl)$_3$ and diglyme were used. 2-Iodopropane (340 mg, 2 mmol, 10 equiv). Very low yield was seen under standard conditions.

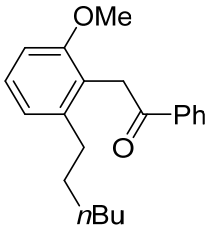
White solid. 15 mg, 30% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 7.3 Hz, 2H), 7.62 (t, *J* = 7.4 Hz, 1H), 7.54 – 7.51 (m, 2H), 7.21 – 7.20 (m, 2H), 7.08 – 7.05 (m, 1H), 4.45 (s, 2H), 2.91 (hept, *J* = 6.8 Hz, 1H), 2.22 (s, 3H), 1.20 (d, *J* = 6.8 Hz, 6H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.2, 147.5, 137.1, 137.0, 133.2, 130.8, 128.7, 128.1, 127.8, 127.3, 123.0, 38.8, 29.9, 23.9, 20.8.

GCMS (EI): Calcd for $C_{18}H_{20}O$: 252.2, found: 252.1.

HRMS (ESI): Calcd for $C_{18}H_{20}O$ $[M+H]^+$ 253.1592, found: 253.1598.



2-(2-*n*-Hexyl-6-methoxyphenyl)-1-phenylethan-1-one (5h).

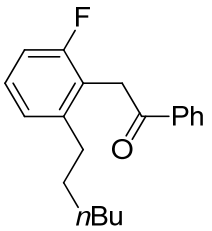
Yellow oil. 32 mg, 51% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.08 (d, *J* = 7.6 Hz, 2H), 7.58 (ψt, *J* = 7.3 Hz, 1H), 7.49 (t, *J* = 7.5 Hz, 2H), 7.20 (ψt, *J* = 7.9 Hz, 1H), 6.86 (d, *J* = 7.7 Hz, 1H), 6.75 (d, *J* = 8.2 Hz, 1H), 4.36 (s, 2H), 3.72 (s, 3H), 2.57 – 2.53 (m, 2H), 1.57 – 1.50 (m, 2H), 1.34 – 1.26 (m, 6H), 0.85 (t, *J* = 6.3 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 198.1, 157.7, 143.2, 137.6, 132.9, 128.6, 128.3, 127.8, 122.4, 121.9, 108.2, 55.7, 36.4, 33.6, 31.8, 31.0, 29.4, 22.7, 14.2.

GCMS (EI): Calcd for $C_{21}H_{26}O_2$: 310.2, found: 310.1.

HRMS (ESI): Calcd for $C_{21}H_{26}O_2$ $[M+H]^+$ 311.2011, found: 311.2013.



2-(2-*n*-Hexyl-6-fluoro-phenyl)-1-phenylethan-1-one (5i).

Yellow oil. 21 mg, 36% yield.

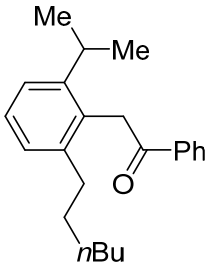
^{1}H NMR (400 MHz, $CDCl_3$): δ 8.07 (d, *J* = 7.8 Hz, 2H), 7.60 (t, *J* = 6.9 Hz, 1H), 7.53 – 7.49 (m, 2H), 7.20 (dd, *J* = 13.9, 7.1 Hz, 1H), 7.01 (d, *J* = 7.6 Hz, 1H), 6.95 – 6.90 (m, 1H), 4.38 (s, 2H), 2.55 – 2.51 (m, 2H), 1.54 – 1.48 (m, 2H), 1.31 – 1.25 (m, 6H), 0.84 (t, *J* = 5.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 196.2, 161.5 (d, J_{C-F} = 243.0 Hz), 144.1 (d, J_{C-F} = 2.6 Hz), 136.8, 133.2, 128.7, 128.2, 128.1, 124.7 (d, J_{C-F} = 2.7 Hz), 120.5 (d, J_{C-F} = 15.3 Hz), 112.5 (d, J_{C-F} = 23.0 Hz), 35.4 (d, J_{C-F} = 3.8 Hz), 33.0, 31.6, 30.7, 29.2, 22.5, 14.0.

^{19}F {^{1}H} NMR (376 MHz, $CDCl_3$): δ -116.0.

GCMS (EI): Calcd for $C_{20}H_{23}FO$: 298.2, found: 298.1.

HRMS (ESI): Calcd for $C_{20}H_{23}FO$ $[M+H]^+$ 299.1811, found: 299.1814.



2-(2-*n*-Hexyl-6-isopropylphenyl)-1-phenylethan-1-one (5j).

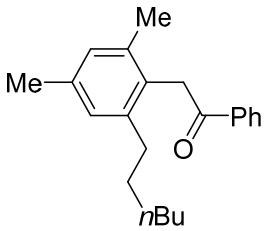
Yellow oil. 39 mg, 60% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.14 (d, *J* = 7.8 Hz, 2H), 7.66 (ψt, *J* = 7.3 Hz, 1H), 7.57 (ψt, *J* = 7.5 Hz, 2H), 7.30 – 7.24 (m, 2H), 7.12 (d, *J* = 7.0 Hz, 1H), 4.50 (s, 2H), 2.95 – 2.88 (m, 1H), 2.57 – 2.53 (m, 2H), 1.60 – 1.52 (m, 2H), 1.38 – 1.23 (m, 12H), 0.87 (t, *J* = 6.4 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.6, 148.0, 141.7, 137.3, 133.3, 130.2, 128.9, 128.2, 127.4, 126.9, 123.2, 38.3, 34.4, 31.8, 31.1, 30.2, 29.5, 24.1, 22.7, 14.2.

GCMS (EI): Calcd for $C_{23}H_{30}O$: 322.2, found: 322.1.

HRMS (ESI): Calcd for $C_{23}H_{30}O$ $[M+H]^+$ 323.2375, found: 323.2372.



2-(2-*n*-Hexyl-4,6-dimethylphenyl)-1-phenylethan-1-one (5k).

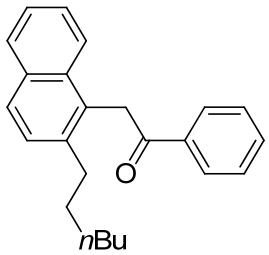
Yellow oil. 45 mg, 73% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 7.6 Hz, 2H), 7.62 (ψt, *J* = 7.3 Hz, 1H), 7.53 (ψt, *J* = 7.5 Hz, 2H), 6.92 (s, 2H), 4.37 (s, 2H), 2.51 – 2.47 (m, 2H), 2.32 (s, 3H), 2.19 (s, 3H), 1.53 – 1.49 (m, 2H), 1.33 – 1.26 (m, 6H), 0.85 (t, *J* = 6.5 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.5, 141.6, 137.3, 137.3, 136.4, 133.2, 129.0, 128.8, 128.7, 128.2, 128.1, 38.9, 34.0, 31.8, 31.2, 29.5, 22.7, 21.2, 20.5, 14.2.

GCMS (EI): Calcd for $C_{22}H_{28}O$: 308.2, found: 308.1.

HRMS (ESI): Calcd for $C_{22}H_{28}O$ $[M+H]^+$ 309.2218, found: 309.2219.



2-(2-*n*-Hexyl-1-naphthyl)acetophenone (5l).

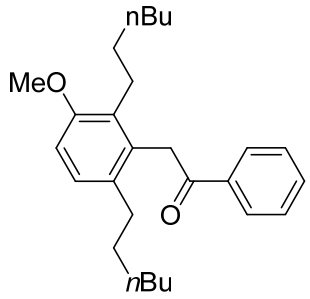
White solid. 40 mg, 60% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.17 (d, *J* = 8.0 Hz, 2H), 7.84 – 7.82 (m, 1H), 7.76 (d, *J* = 7.4 Hz, 1H), 7.70 – 7.68 (m, 1H), 7.64 (d, *J* = 7.2 Hz, 1H), 7.56 (ψt, *J* = 7.2 Hz, 2H), 7.42 – 7.38 (m, 3H), 4.83 (s, 2H), 2.77 – 2.73 (m, 2H), 1.65 – 1.58 (m, 2H), 1.38 – 1.27 (m, 6H), 0.85 (t, *J* = 7.4 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 197.2, 139.5, 137.1, 133.3, 133.0, 132.5, 128.8, 128.6, 128.2, 127.9, 127.5, 126.2, 124.7, 123.6, 38.3, 34.4, 31.7, 31.3, 29.4, 22.6, 14.1.

GCMS (EI): Calcd for $C_{24}H_{26}O$: 330.2, found: 330.0.

HRMS (ESI): Calcd for $C_{24}H_{26}O$ $[M+H]^+$ 331.2062, found: 331.2073.



2-(2,6-Di-*n*-hexyl-3-methoxyphenyl)acetophenone (5m).

Yellow oil. 64 mg, 81% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 – 8.07 (m, 2H), 7.63 – 7.59 (m, 1H), 7.54 – 7.50 (m, 2H), 7.03 (d, *J* = 8.4 Hz, 1H), 6.77 (d, *J* = 8.4 Hz, 1H), 4.39 (s, 2H), 3.80 (s, 3H), 2.52 – 2.48 (m, 2H), 2.45 – 2.41 (m, 2H), 1.51 – 1.21 (m, 16H), 0.84 -0.79 (m, 6H).

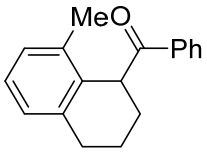
^{13}C NMR (100 MHz, $CDCl_3$): δ 197.5, 155.8, 137.2, 133.8, 133.1, 132.3, 130.7, 128.7, 128.0, 127.0, 109.3, 55.4, 38.9, 33.5, 31.7, 31.6, 31.1, 29.7, 29.3, 27.2, 22.6, 14.0.

GCMS (EI): Calcd for $C_{27}H_{38}O_2$: 394.3, found: 394.2.

HRMS (ESI): Calcd for $C_{27}H_{38}O_2$ $[M+H]^+$ 395.2950, found: 395.2950.

IV. Procedure for synthesis of substituted tetralines and benzocycloheptane derivatives, and characterization of products

A typical procedure for the synthesis of substituted tetralines and benzocycloheptene: In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with $PdBr_2$ (10 mol%, 5.3 mg, 0.02 mmol), P(*m*-anisyl)$_3$ (20 mol%, 14 mg, 0.04 mmol) and dry THF (2.0 mL). After stirring for about 10 min at room temperature, *o*-iodotoluene (44 mg, 0.2 mmol), 1-bromo-3-chloropropane (126 mg, 0.8 mmol), norbornene (38 mg, 0.4 mmol), NaOH powder (24 mg, 0.6 mmol), acetophenone (48 mg, 0.4 mmol) and GC standard *n*-dodecane (20 μL) were added sequentially. The tube was capped tightly and the reaction mixture was heated at 100 °C for 24 h. At the end of reaction, the mixture was cooled to rt. The desired products were purified by flash chromatography over silica gel using 25:1 hexanes/EA.



1-benzoyl-8-methyltetraline (6a).

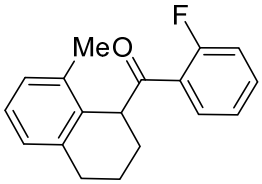
Light yellow solid. 23 mg, 46% yield. When 1,3-dibromopropane (162 mg, 0.8 mmol, 4 equiv) was used instead, the yield decreased to 20%.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 – 8.11 (m, 2H), 7.63 (ψt, *J* = 7.3 Hz, 1H), 7.54 (ψt, *J* = 7.5 Hz, 2H), 7.15 (ψt, *J* = 7.5 Hz, 1H), 7.07 (d, *J* = 7.5 Hz, 1H), 7.02 (d, *J* = 7.3 Hz, 1H), 4.93 (t, *J* = 5.1 Hz, 1H), 2.93 (dt, *J* = 16.7, 4.5 Hz, 1H), 2.87 – 2.79 (m, 1H), 2.19 – 2.14 (m, 2H), 2.08 (s, 3H), 1.81 – 1.75 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.5, 138.2, 136.4, 136.1, 133.5, 133.1, 128.9, 128.5, 127.8, 127.3, 126.6, 44.4, 29.8, 27.5, 20.1, 19.2.

MS (EI) Calcd for $C_{18}H_{18}O$: 250.1; found: 250.1.

HRMS (ESI): Calcd for $C_{18}H_{18}O$ $[M+H]^+$ 251.1436, found: 251.1441.



1-(*o*-Fluorobenzoyl)-8-methyltetraline (6b).

Light yellow solid. 31 mg, 57% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86 (td, *J* = 7.6, 1.8 Hz, 1H), 7.57 – 7.51 (m, 1H), 7.25 (ψt, *J* = 7.5 Hz, 1H), 7.18 (dd, *J* = 11.3,

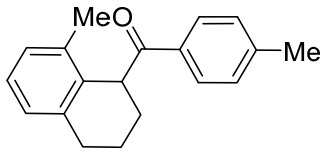
8.3 Hz, 1H), 7.13 – 7.09 (m, 1H), 7.02 – 7.00 (m, 2H), 4.78 (dd, J = 6.9, 2.5 Hz, 1H), 2.90 – 2.74 (m, 2H), 2.18 – 2.15 (m, 1H), 2.10 (s, 3H), 2.08 – 2.02 (m, 1H), 1.77 – 1.62 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 200.0 (d, J = 5.2 Hz), 161.4 (d, $J_{C\text{-}F}$ = 253.1 Hz), 137.9, 136.8, 134.4 (d, $J_{C\text{-}F}$ = 9.0 Hz), 133.2, 131.5 (d, $J_{C\text{-}F}$ = 2.9 Hz), 127.8, 127.3, 126.8, 125.6 (d, $J_{C\text{-}F}$ = 13.7 Hz), 124.9 (d, $J_{C\text{-}F}$ = 3.5 Hz), 116.8 (d, $J_{C\text{-}F}$ = 24.4 Hz), 48.8 (d, $J_{C\text{-}F}$ = 7.7 Hz), 29.8, 26.3, 19.9, 19.0.

^{19}F {^{1}H} NMR (376 MHz, $CDCl_3$): δ -110.1.

MS (EI): Calcd for $C_{18}H_{11}FO$: 268.1; found: 268.1.

HRMS (ESI): Calcd for $C_{18}H_{11}FO$ $[M+H]^+$ 269.1342, found: 269.1346.



1-(*p*-Methylbenzoyl)-8-methyltetraline (6c).

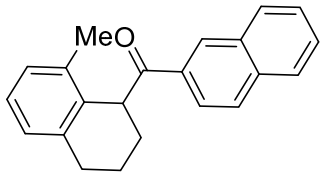
Light yellow oil. 25 mg, 47% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.99 (d, J = 8.2 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 7.11 (ψt, J = 7.5 Hz, 1H), 7.03 (d, J = 7.4 Hz, 1H), 6.99 (d, J = 7.3 Hz, 1H), 4.87 (t, J = 5.1 Hz, 1H), 2.93 – 2.76 (m, 2H), 2.45 (s, 3H), 2.15 – 2.11 (m, 2H), 2.04 (s, 3H), 1.79 – 1.72 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.2, 143.9, 138.3, 136.5, 133.7, 133.7, 129.6, 128.7, 127.8, 127.3, 126.6, 44.4, 29.9, 27.7, 21.8, 20.2, 19.3.

MS (EI) Calcd for $C_{19}H_{20}O$: 264.2; found: 264.1.

HRMS (ESI): Calcd for $C_{19}H_{20}O$ $[M+H]^+$ 265.1592, found: 265.1597.



1-(Napth-2-oyl)-8-methyltetraline (6d).

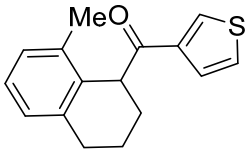
Light yellow oil. 29 mg, 48% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.62 (s, 1H), 8.12 (dd, J = 8.6, 1.7 Hz, 1H), 8.00 (d, J = 8.0 Hz, 1H), 7.93 (d, J = 8.6 Hz, 1H), 7.90 (d, J = 8.0 Hz, 1H), 7.63 – 7.55 (m, 2H), 7.12 (ψt, J = 7.5 Hz, 1H), 7.05 (d, J = 7.5 Hz, 1H), 7.00 (d, J = 7.3 Hz, 1H), 5.04 (t, J = 5.1 Hz, 1H), 2.95 – 2.78 (m, 2H), 2.22 – 2.18 (m, 2H), 2.07 (s, 3H), 1.83 – 1.74 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.6, 138.3, 136.6, 135.7, 133.6, 133.5, 132.8, 129.79, 129.76, 128.8, 128.6, 127.9, 127.8, 127.4, 126.9, 126.7, 124.6, 44.6, 29.9, 27.8, 20.2, 19.3.

MS (EI): Calcd for $C_{22}H_{20}O$: 300.2; found: 300.1.

HRMS (ESI): Calcd for $C_{22}H_{20}O$ $[M+H]^+$ 301.1592, found: 301.1590.



1-(Thien-3-oyl)-8-methyltetraline (6e).

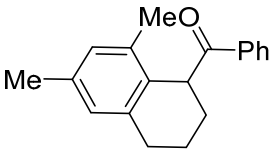
Light yellow oil. 20 mg, 39% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 (dd, *J* = 2.9, 1.2 Hz, 1H), 7.60 (dd, *J* = 5.1, 1.2 Hz, 1H), 7.34 (dd, *J* = 5.1, 2.9 Hz, 1H), 7.11 (ψt, *J* = 7.5 Hz, 1H), 7.03 (d, *J* = 7.5 Hz, 1H), 6.99 (d, *J* = 7.3 Hz, 1H), 4.62 (dd, *J* = 6.3, 4.3 Hz, 1H), 2.93 – 2.76 (m, 2H), 2.19 – 2.13 (m, 2H), 2.06 (s, 3H), 1.83 – 1.73 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 196.3, 141.3, 138.2, 136.8, 133.3, 132.0, 127.9, 127.7, 127.4, 126.8, 126.4, 47.1, 30.0, 28.0, 20.2, 19.5.

MS (EI): Calcd for $C_{16}H_{16}OS$: 256.1; found: 256.0.

HRMS (ESI): Calcd for $C_{16}H_{16}OS$ $[M+H]^+$ 257.1000, found: 257.1006.



1-Benzoyl-6,8-dimethyltetraline (6f).

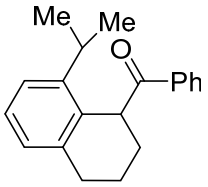
Light yellow oil. 29 mg, 54% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 – 8.08 (m, 2H), 7.60 (ψt, *J* = 7.4 Hz, 1H), 7.51 (ψt, *J* = 7.5 Hz, 2H), 6.87 (s, 1H), 6.84 (s, 1H), 4.86 (t, *J* = 5.1 Hz, 1H), 2.90 – 2.73 (m, 2H), 2.29 (s, 3H), 2.15 – 2.10 (m, 2H), 2.02 (s, 3H), 1.77 – 1.71 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.8, 138.1, 136.3, 136.3, 136.1, 133.1, 130.5, 128.9, 128.9, 128.5, 127.9, 44.2, 29.8, 27.7, 21.1, 20.0, 19.3.

MS (EI): Calcd for $C_{19}H_{20}O$: 264.2; found: 264.1.

HRMS (ESI): Calcd for $C_{19}H_{20}O$ $[M+H]^+$ 265.1592, found: 265.1586.



1-Benzoyl-8-isopropyltetraline (6g).

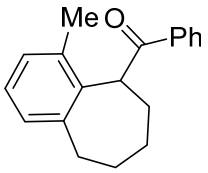
Light yellow oil. 32 mg, 58% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 – 8.07 (m, 2H), 7.62 (ψt, *J* = 7.3 Hz, 1H), 7.53 (ψt, *J* = 7.5 Hz, 2H), 7.21 (ψt, *J* = 7.6 Hz, 1H), 7.13 (d, *J* = 7.3 Hz, 1H), 7.03 (d, *J* = 7.4 Hz, 1H), 5.04 (dd, *J* = 6.8, 3.1 Hz, 1H), 2.95 – 2.79 (m, 2H), 2.73 – 2.63 (m, 1H), 2.20 – 2.05 (m, 2H), 1.76 – 1.70 (m, 2H), 1.17 (d, *J* = 6.8 Hz, 3H), 1.02 (d, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.5, 147.2, 138.1, 136.2, 133.1, 131.9, 129.0, 128.5, 127.3, 127.1, 123.2, 43.5, 30.2, 29.5, 27.6, 24.6, 23.2, 18.9.

MS (EI): Calcd for $C_{20}H_{22}O$: 278.2, found: 278.0.

HRMS (ESI): Calcd for $C_{20}H_{22}O$ $[M+H]^+$ 279.1749, found: 279.1751.



1-Benzoyl-9-methylbenzocycloheptene (7).

$Pd(OAc)_2$ (4.4 mg, 0.02 mmol) and 1,4-dibromobutane (162 mg, 0.8 mmol, 4 equiv) were used.

Light yellow oil. 31 mg, 59% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.89 – 7.87 (m, 2H), 7.53 (t, *J* = 7.4 Hz, 1H), 7.44 (t, *J* = 7.5 Hz, 2H), 7.08 – 7.00 (m, 3H), 5.06 (dd, *J* = 6.5, 4.4 Hz, 1H), 3.03 – 2.96 (m, 1H), 2.74 – 2.68 (m, 1H), 2.42 – 2.34 (m, 1H), 2.30 (s, 3H), 2.02 – 1.94 (m, 1H), 1.87 – 1.80 (m, 1H), 1.69 – 1.60 (m, 2H), 1.54 – 1.43 (m, 1H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 201.7, 143.9, 138.2, 137.9, 136.0, 132.6, 128.9, 128.72, 128.70, 128.3, 127.0, 50.1, 35.8, 29.9, 27.3, 26.4, 21.5.

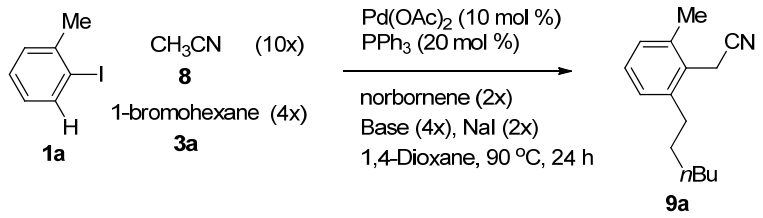
MS (ESI) Calcd for $C_{19}H_{20}O$: 264.2, found: 264.1.

HRMS (ESI): Calcd for $C_{19}H_{20}O$ $[M+H]^+$ 265.1592, found: 265.1598.

V. Condition optimization for couplings of acetonitrile

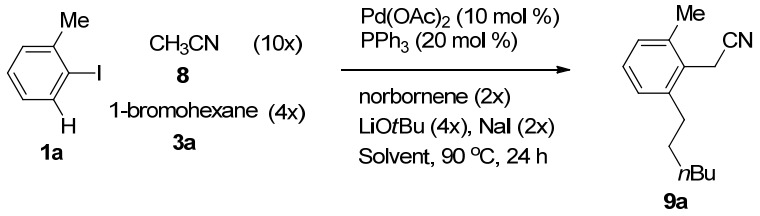
A typical procedure for condition optimization for a model coupling of acetonitrile: In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with $Pd(OAc)_2$ (10 mol%, 2.2 mg, 0.01 mmol), P(*p*-tolyl)$_3$ (20 mol%, 6.1 mg, 0.02 mmol) and dry 1,4-dioxane (0.5 mL). After stirring for about 10 min at room temperature, *o*-iodotoluene (22 mg, 0.1 mmol), 1-bromohexane (66 mg, 0.4 mmol), norbornene (19 mg, 0.2 mmol), LiO*t*Bu (32 mg, 0.4 mmol), NaI (30 mg, 0.2 mmol), MeCN (50 μL, 1 mmol) and GC standard *n*-dodecane (10 μL) were added sequentially. The tube was capped tightly and the reaction mixture was heated at 90 °C for 24 h. At the end of reaction, the mixture was cooled to rt. Aliquots of the reaction mixture were passed through a short plug of silica gel with ethyl acetate washings. The filtrate was analyzed by GC for the determination of the conversion of *o*-iodotoluene and the calibrated GC yield of the product.

Table S14. The effect of bases in the reaction of acetonitrile



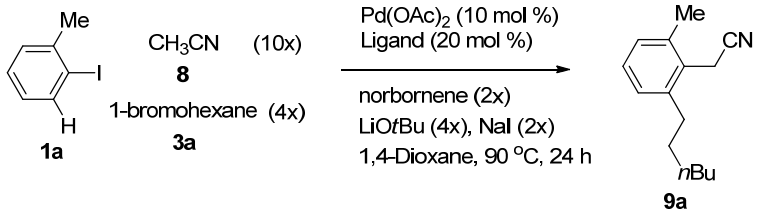
entry	base	conv. of ArI (%)	**9a** (%)
1	NaOH	100	4
2	KOH	72	0
3	NaOPh	62	0
4	$CsOH{\cdot}H_2O$	87	0
5	Cs_2CO_3	100	0
6	K_3PO_4	75	0
7	NaOMe	100	0
8	KOMe	100	0
9	**LiO*t*Bu**	**82**	**48**
10	NaO*t*Bu	100	26
11	KO*t*Bu	43	0
12	LiHMDS	29	0
13	NaHMDS	21	0
17	KHMDS	98	0

Table S15. The effect of solvents in the reaction of acetonitrile



Entry	Solvent	Conv of ArI (%)	**9a** (%)
1	MeCN	70	26
2	**1,4-Dioxane**	**69**	**48**
3	THF	80	11
4	DME	100	0
5	THP	77	34
6	Diglyme	74	0

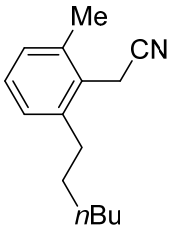
Table S16. The effect of ligands in the reaction of acetonitrile



Entry	Ligand	Conv. of ArI (%)	**9a** (%)
1	P(2-furyl)$_3$	91	38
2	P(2-thienyl)$_3$	92	32
3	P(phenyl)$_3$	94	44
4	P(*p*-anisyl)$_3$	67	33
5	**P(*p*-tolyl)$_3$**	**98**	**51**
6	P(*m*-toyl)3	97	32
7	P(*m*-anisyl)$_3$	98	42

VI. Procedure for couplings of acetonitrile and characterization of products

A typical procedure for couplings of acetonitrile: In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with $Pd(OAc)_2$ (10 mol%, 4.4 mg, 0.02 mmol), P(*p*-tolyl)$_3$ (20 mol%, 12 mg, 0.04 mmol) and dry 1,4-dioxane (1 mL). After stirring for about 10 min at room temperature, *o*-iodotoluene (44 mg, 0.2 mmol), 1-bromohexane (132 mg, 0.8 mmol), norbornene (38 mg, 0.4 mmol), LiO*t*Bu (64 mg, 0.8 mmol), NaI (60 mg, 0.4 mmol), MeCN (100 μL, 2 mmol) and GC standard *n*-dodecane (20 μL) were added sequentially. For reactions using alkyl iodides, NaI was not added. The tube was capped tightly and the reaction mixture was heated at 90 ^{o}C for 24 h. The desired products were purified by flash chromatography over silica gel using 20:1 hexanes/EA.



2-Cyanomethyl-3-*n*-hexyltoluene (9a).

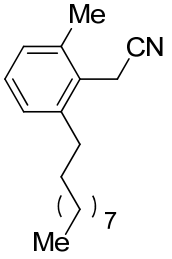
Yellow oil. 22 mg, 50% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.19 – 7.15 (m, 1H), 7.08 – 7.07 (m, 2H), 3.66 (s, 2H), 2.69 – 2.65 (m, 2H), 2.42 (s, 3H), 1.64 – 1.57 (m, 2H), 1.42 – 1.30 (m, 6H), 0.90 (t, *J* = 7.1 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.4, 137.2, 128.7, 128.4, 127.9, 127.0, 117.8, 33.9, 31.8, 31.1, 29.4, 22.7, 20.3, 17.5, 14.2.

GCMS (EI): Calcd for $C_{15}H_{21}N$: 215.2, found: 215.1.

HRMS (ESI): Calcd for $C_{15}H_{21}N$ $[M+H]^+$ 216.1752, found: 216.1770.



2-Cyanomethyl-3-*n*-decyltoluene (9b).

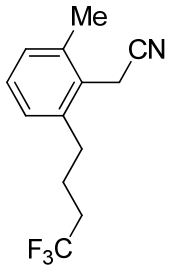
Yellow oil. 25 mg, 46% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.19 – 7.15 (m, 1H), 7.08 – 7.06 (m, 2H), 3.66 (s, 2H), 2.68 – 2.64 (m, 2H), 2.42 (s, 3H), 1.63 – 1.58 (m, 2H), 1.39 – 1.27 (m, 14H), 0.88 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.3, 137.1, 128.6, 128.2, 127.8, 126.9, 117.6, 33.8, 31.9, 31.0, 29.6, 29.60, 29.59, 29.5, 29.3, 22.7, 20.1, 17.4, 14.1.

GCMS (EI): Calcd for $C_{19}H_{29}N$: 271.2, found: 271.2.

HRMS (ESI): Calcd for $C_{19}H_{29}N$ $[M+H]^+$ 272.2378, found: 272.2383.



2-Cyanomethyl-3-*(*4,4,4-trifluorobutyl)toluene (9c).

Yellow oil. 16 mg, 34% yield.

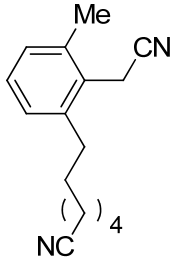
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.21 (dd, *J* = 7.6, 7 .3 Hz, 1H), 7.12 (d, *J* = 7.3 Hz, 1H), 7.07 (d, *J* = 7.6 Hz, 1H), 3.66 (s, 2H), 2.79 – 2.75 (m, 2H), 2.43 (s, 3H), 2.24 – 2.12 (m, 2H), 1.94 – 1.86 (m, 2H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 139.2, 137.4, 129.3, 128.5, 127.6, 127.03, 127.00 (q, $J_{C\text{-}F}$= 276.3 Hz), 117.3, 33.3 (q, $J_{C\text{-}F}$ = 28.8 Hz), 32.2, 22.9 (q, $J_{C\text{-}F}$ = 2.5 Hz), 20.2, 17.3.

^{19}F NMR (376 MHz, $CDCl_3$): δ -66.0.

GCMS (EI): Calcd for $C_{13}H_{14}F_3N$: 241.1, found: 241.1.

HRMS (ESI): Calcd for $C_{13}H_{14}F_3N$ $[M+H]^+$ 242.1157, found: 242.1140.



2-Cyanomethyl-3-(6-cyanohexyl)toluene (9d).

Yellow oil. 20 mg, 41% yield.

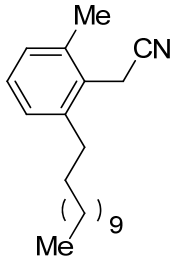
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.20 – 7.16 (m, 1H), 7.10 – 7.05 (m, 2H), 3.66 (s, 2H), 2.70 – 2.66 (m, 2H), 2.42 (s, 3H), 2.34 (t, *J* = 7.1 Hz, 2H), 1.71 – 1.60 (m, 4H), 1.55 – 1.43 (m, 4H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 140.7, 137.2, 128.8, 128.3, 127.8, 126.9, 119.7, 117.6, 33.5, 30.5, 28.6, 28.5, 25.3, 20.2, 17.4,

17.1.

GCMS (EI): Calcd for $C_{16}H_{20}N_2$: 240.2, found: 240.1.

HRMS (ESI): Calcd for $C_{16}H_{20}N_2$ $[M+H]^+$ 241.1705, found: 241.1720.



2-Cyanomethyl-3-*n*-decyltoluene (9e).

1-Iodododecane (237 mg, 0.8 mmol, 4 equiv) was used.

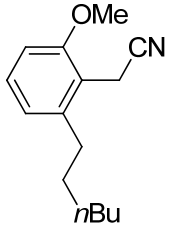
Yellow oil. 28 mg, 47% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.19 – 7.15 (m, 1H), 7.08 – 7.06 (m, 2H), 3.66 (s, 2H), 2.68 – 2.64 (m, 2H), 2.41 (s, 3H), 1.61 – 1.58 (m, 2H), 1.29 – 1.26 (m, 18H), 0.88 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.3, 137.1, 128.6, 128.2, 127.8, 126.9, 117.6, 33.8, 31.9, 31.0, 29.7, 29.64, 29.59, 29.5, 29.3, 22.7, 20.1, 17.4, 14.1.

GCMS (EI): Calcd for $C_{21}H_{33}N$: 299.3, found: 299.2.

HRMS (ESI): Calcd for $C_{21}H_{33}N$ $[M+H]^+$ 300.2691, found: 300.2693.



2-Cyanomethyl-3-*n*-hexylanisole (9f).

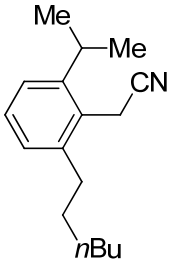
Yellow oil. 15 mg, 32% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.25 – 7.21 (m, 1H), 6.82 (d, *J* = 7.6 Hz, 1H), 6.76 (d, *J* = 8.2 Hz, 1H), 3.87 (s, 3H), 3.69 (s, 2H), 2.66 – 2.62 (m, 2H), 1.63 – 1.57 (m, 2H), 1.40 – 1.29 (m, 6H), 0.89 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 157.4, 142.6, 129.0, 121.9, 118.3, 117.0, 108.3, 55.7, 33.3, 31.7, 30.8, 29.3, 22.6, 14.2, 14.1.

GCMS (EI): Calcd for $C_{15}H_{21}NO$: 231.1, found: 231.1.

HRMS (ESI): Calcd for $C_{15}H_{21}NO$ $[M+H]^+$ 232.1701, found: 232.1710.



2-Cyanomethyl-3-*n*-hexylcumene (9g).

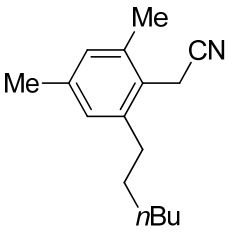
Yellow oil. 23 mg, 47% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28 – 7.24 (m, 1H), 7.19 (d, *J* = 7.4 Hz, 1H), 7.07 (d, *J* = 7.3 Hz, 1H), 3.72 (s, 2H), 3.17 (hept, *J* = 6.9 Hz, 1H), 2.69 – 2.65 (m, 2H), 1.65 – 1.58 (m, 2H), 1.45 – 1.28 (m, 12H), 0.90 (t, *J* = 6.9 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 147.5, 141.4, 128.6, 127.5, 125.5, 123.8, 118.3, 34.1, 31.7, 30.9, 29.9, 29.4, 23.8, 22.6, 16.5, 14.1.

GCMS (EI): Calcd for $C_{17}H_{25}N$: 243.2, found: 243.1.

HRMS (ESI): Calcd for $C_{17}H_{25}N$ $[M+H]^+$ 244.2065, found: 244.2059.



4-Cyanomethyl-5-*n*-hexyl-*m*-xylene (9h).

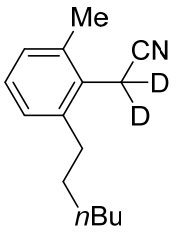
Yellow oil. 24 mg, 52% yield.

^{1}H NMR (400 MHz, $CDCl_3$): δ 6.90 – 6.89 (m, 2H), 3.62 (s, 2H), 2.63 – 2.59 (m, 2H), 2.37 (s, 3H), 2.28 (s, 3H), 1.62 – 1.56 (m, 2H), 1.42 – 1.32 (m, 6H), 0.90 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.2, 137.9, 136.9, 129.4, 128.5, 123.9, 117.8, 33.7, 31.7, 31.1, 29.4, 22.6, 21.0, 20.0, 17.1, 14.1.

GCMS (EI): Calcd for $C_{16}H_{23}N$: 229.2, found: 229.1.

HRMS (ESI): Calcd for $C_{16}H_{23}N$ $[M+H]^+$ 230.1909, found: 230.1928.



d_2-2-Cyanomethyl-3-*n*-hexyltoluene (9i).

CD_3CN (110 μL, 2 mmol, 10 equiv) was used.

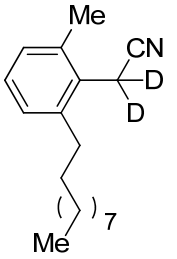
Yellow oil. 24 mg, 56% yield with 1.32D.

^1H NMR (400 MHz, $CDCl_3$): δ 7.19 – 7.15 (m, 1H), 7.08 – 7.06 (m, 2H), 3.66 – 3.64 (m, 0.68H), 2.68 – 2.64 (m, 2H), 2.41 (s, 3H), 1.64 – 1.58 (m, 2H), 1.42 – 1.32 (m, 6H), 0.90 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.3, 137.1, 128.6, 128.2, 127.8, 126.9 (m), 117.6, 33.7 (m), 31.7, 30.9, 29.3, 22.6, 20.1, 17.4, 14.1.

GCMS (EI): Calcd for $C_{15}H_{19}D_2N$: 217.2, found: 217.0.

HRMS (ESI): Calcd for $C_{15}H_{19}D_2N$ $[M+H]^+$ 218.1878, found: 218.1865.



d_2-2-(2-Decyl-6-methylphenyl)acetonitrile (9j).

CD_3CN (110 μL, 2 mmol, 10 equiv) was used.

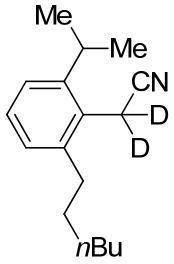
Yellow oil. 22 mg, 41% yield with 1.78D.

^1H NMR (400 MHz, $CDCl_3$): δ 7.19 – 7.15 (m, 1H), 7.08 – 7.06 (m, 2H), 3.66 – 3.64 (m, *0.22H*), 2.67 – 2.63 (m, 2H), 2.41 (s, 3H), 1.63 – 1.58 (m, 2H), 1.39 – 1.27 (m, 14H), 0.88 (t, *J* = 6.8 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.4, 137.2, 128.7, 128.3, 127.9, 126.9, 117.7, 33.8, 32.0, 31.1, 29.74, 29.70, 29.69, 29.59, 29.4, 22.8, 20.2, 14.2.

GCMS (EI): Calcd for $C_{19}H_{27}D_2N$: 273.2, found: 273.2.

HRMS (ESI): Calcd for $C_{19}H_{27}D_2N$ $[M+H]^+$ 274.2504, found: 274.2492.



d_2-2-(2-Hexyl-6-isopropylphenyl)acetonitrile (9k).

CD_3CN (110 μL, 2 mmol, 10 equiv) was used.

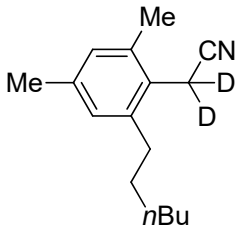
Yellow oil. 24 mg, 49% yield with 1.51D.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.28 – 7.24 (m, 1H), 7.19 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.06 (dd, *J* = 7.4, 1.3 Hz, 1H), 3.72 -3.71 (m, *0.49H*), 3.16 (hept, *J* = 6.7 Hz, 1H), 2.69 – 2.65 (m, 2H), 1.65 – 1.59 (m, 2H), 1.45 – 1.32 (m, 6H), 1.29 (d, *J* = 6.8 Hz, 6H), 0.90 (t, *J* = 7.0 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 147.5, 141.4, 128.6, 127.5, 123.8, 118.3, 34.1, 31.7, 30.9, 29.8, 29.4, 23.8, 22.6, 14.1.

GCMS (EI): Calcd for $C_{17}H_{23}D_2N$: 245.2, found: 245.1.

HRMS (ESI): Calcd for $C_{17}H_{23}D_2N$ $[M+H]^+$ 246.2191, found: 246.2182.



d_2-4-Cyanomethyl-5-*n*-hexyl-*m*-xylene (9l).

CD_3CN (110 μL, 2 mmol, 10 equiv) was used.

Yellow oil. 28 mg, 60% yield with 1.28D.

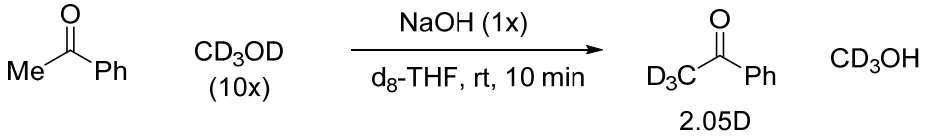
^{1}H NMR (400 MHz, $CDCl_3$): δ 6.90 – 6.89 (m, 2H), 3.62 – 3.60 (m, *0.72H*), 2.63 – 2.59 (m, 2H), 2.37 (s, 3H), 2.28 (s, 3H), 1.62 – 1.54 (m, 2H), 1.42 – 1.32 (m, 6H), 0.90 (t, *J* = 6.7 Hz, 3H).

^{13}C NMR (100 MHz, $CDCl_3$): δ 141.3, 138.0, 137.0, 129.5, 128.6, 123.9 (m) 117.9, 33.8 (m), 31.8, 31.2, 29.5, 22.7, 21.1, 20.1, 17.2, 14.2.

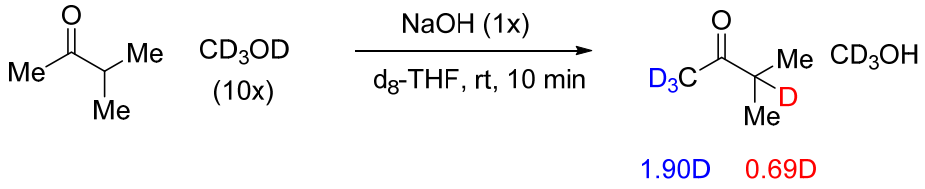
GCMS (EI): Calcd for $C_{16}H_{21}D_2N$: 231.2, found: 231.0.

HRMS (ESI): Calcd for $C_{16}H_{21}D_2N$ $[M+H]^+$ 232.2034, found: 232.2043.

VII. H/D exchange experiments



In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with powder NaOH (0.1 mmol, 4 mg) and acetophenone (0.1 mmol, 12 μL), d_4-methnaol (1 mmol, 41 μL) and d_8-THF (0.5 mL) in a vial and stirred for 10 min at RT. The suspension was quickly filtered through Celite into a NMR tube. Quantitative NMR spectroscopy was performed with a T1 of 100 sec. Only the decrease of α protons was detected and quantified by signal integration. No byproduct of thes ketone was seen.



In an argon-filled glove box, a 10-mL reaction tube containing a magnetic stir bar was charged with powder NaOH (0.1 mmol, 4 mg) and 3-methylbutan-2-one (0.1 mmol, 11 μL), d_4-methnaol (1 mmol, 41 μL) and d_8-THF (0.5 mL) in a vial and stirred for 10 min at RT. The suspension was quickly filtered through Celite into a NMR tube. Quantitative NMR spectroscopy was performed with a T1 of 100 sec. Only the decrease of α protons was detected and quantified by signal integration. No byproduct of the ketone was seen.